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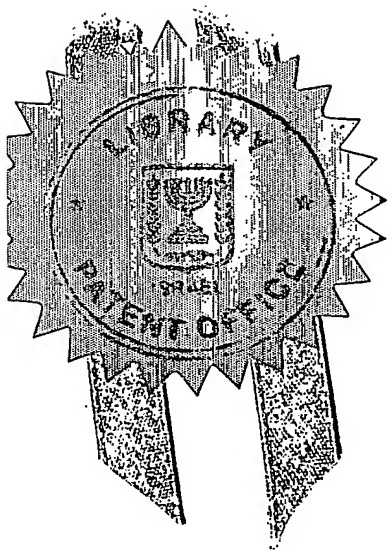

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חוק הפטנטים, תשכ"ז – 1967
PATENTS LAW, 5727-1967

בקשה לפטנט
Application For Patent

לשימוש הלשכה
For Office Use

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תאריך: Date	
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אני, (שם המבקש, מענו ולגבי גוף מאוגד: מקום התאגדותו)
I, (Name and address of applicant, and in case of body corporate-place of incorporation)

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(בעברית)
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(באנגלית)
(English)

Tunable laser

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Hereby apply for a patent to be granted to me in respect thereof.

* בקשת חלוקה Application of Division	* בקשת פטנט מוסף Appl. for Patent of Addition
מבקשת פטנט from application No. מס'	* לבקשה/לפטנט to Patent/Appl. No. מס'
Dated מיום	Dated מיום

דרישת דין קדימה* Priority Claim		
מספר/סימן Number/Mark	תאריך Date	מדינת האיגוד Convention Country

P.o.A.: General כללי
filed in case P135806 * יפוי כח: הוגש בעניין

C. 141117

המען למסירת מסמכים בישראל
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Signature of Applicant
בשם המבקשים,
ריינהולד כהן ושותפיו
ע"י: -

היום This 8 בחודש of October שנת Year 2002

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Tunable laser

למבדה קרוסינג בע"מ

Lambda Crossing Ltd.

C. 141117

TUNABLE LASER

FIELD OF THE INVENTION

This invention relates to a tunable laser device and a method thereof.

BACKGROUND OF THE INVENTION

A tunable laser is composed of a closed loop optical cavity, which encompasses a gain medium and a tunable filter. In the literature one can find many embodiments of tunable lasers. The gain material can be a semiconductor based structure where the active material can be InP, GaAs, InGaAs etc. and the tunable filter can be realized as a Microresonator, waveguide grating, fiber grating or bulk grating. The laser can be realized either by monolithic integration where by all structures are realized in the semiconductor substrate or by hybrid integration where the tuning elements is realized in a different optical medium.

SUMMARY OF THE INVENTION

According to one embodiment, the invention discloses a Sagnac loop composed of two resonators or more resonators. According to another embodiment, the invention discloses a Sagnac loop composed of two resonators or more resonators and acting as a reflective filter. According to yet another embodiment, the invention discloses a Sagnac loop composed of two resonators or more resonators and acting as a reflective tunable filter. Further more, the invention discloses a Sagnac loop composed of two resonators or more resonators with different circumference and acting as a reflective filter.

According to another embodiment, the invention discloses a laser composed of an optimized coating, a gain section, anti reflection coating and a Sagnac loop composed of two or more resonators acting as a tunable filter. According to yet another embodiment, the invention discloses a laser composed of an optimized

coating, a gain section, anti reflection coating and a Sagnac loop composed of two or more resonators acting as a tunable filter in which the gain section is a semiconductor material such as GaN, InP, InGaAs, GaAs.

The invention further discloses a laser composed of an optimized coating, a waveguide in a gain section, anti reflection coating and a waveguide Sagnac loop composed of two or more resonators acting as a tunable filter. According to another embodiment, the invention discloses a laser composed of an optimized coating, a waveguide in a gain section, anti reflection coating and a waveguide Sagnac loop composed of two or more resonators acting as a tunable filter, in which the waveguides are terminated by a taper structure to reduce loss at the interface between the elements.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to understand the invention and to see how it may be carried out in practice, a preferred embodiment will now be described, by way of non-limiting example only, with reference to the accompanying drawings, in which:

Figure 1a is an outline of bi direction tunable filter based on Sagnac Loop using a single resonator;

Figure 1b is an outline of bi direction tunable filter based on Sagnac Loop using two resonators; and

Figure 2 shows a Laser cavity.

DETAILED DESCRIPTION OF THE INVENTION

The present invention makes use of a tunable filter based on micro ring resonators to create a tunable laser cavity. Ring resonators can provide for extremely high quality tunable filters. However they present a unique channel in integration in a tunable laser. Their uni-directional nature, i.e. light propagates in only one direction, presents a unique problem in designing the laser cavity. One approach is to structure the cavity as outlined in [WO02/21650], where the laser is constructed in a ring structure and is also unidirectional in its operation. An

alternative is disclosed within where a Sagnac loop [US 5420684 figure 3] composed of ring resonators is constructed, and used as a bi directional tunable filter.

The bi directional filter is shown in figure 1a and b.

In figure 1a, light enters the waveguide (101) and reaches a coupler or Y coupler at 201, which splits the light equally between the two waveguide 102, and 103. The light at 102 is coupled into the resonator 202, and for resonant frequencies it is transferred to 105. The filtered light is directed back to the coupler 201. The same occurs in the opposite direction and the two split portions meet again at the coupler. Since both transverse the same distance they arrive at the coupler with equal optical phase, which results at a coherent buildup of the light back at the input waveguide. If the optical fields had been out of phase then a portion of the light would be directed back into waveguide and a portion would be directed into another waveguide or mode depending on the structure of the coupler.

In figure 1b, light enters the waveguide (101) and reaches a coupler or Y coupler at 201, which splits the light equally between the two waveguide 102, and 103. The light at 102, is coupled into the resonator 202, and for resonant frequencies it is transferred to 105. Light is again coupled into the resonator 203 and for resonant frequencies is transferred to 106. The twice-filtered light is directed back to the coupler 201. The same occurs in the opposite direction and the two split portions meet again at the coupler. Since both transversed the same distance they arrive at the coupler with equal optical phase which results at a coherent buildup of the light back at the input waveguide. If the optical fields had been out of phase then a portion of the light would be directed back into waveguide and a portion would be directed into another waveguide or mode depending on the structure of the coupler.

The advantages of using two or more resonators in the context of a tunable filter are:

1. Enhanced filter characteristics (rejection ratio)

2. Extended free spectral range (FSR) and tuning range by using the vernier effect

The laser cavity is now constructed as shown in figure 2.

The cavity is composed of an optimized coating on the external laser facet, which provides for feedback into the cavity, a gain section that provides the laser gain, an anti reflection coating which permits low loss coupling and low back reflections of the gain section into the filter section, and a reflective filter section. In one preferred embodiment the reflective filter section is composed of a Sagnac loop with two ring resonators in the loop, which provides for enhanced filter characteristics and extended FSR and tuning range.

While there has been shown and disclosed preferred embodiments of a tunable device and method in accordance with the invention, it will be appreciated that many changes may be made therein without departing from the spirit of the invention.

CLAIMS:

1. A tunable laser device as hereinbefore described and exemplified with reference to the accompanying drawings.
2. A tunable laser method as hereinbefore described and exemplified with reference to the accompanying drawings.

For the Applicants,
REINHOLD COHN AND PARTNERS
By:

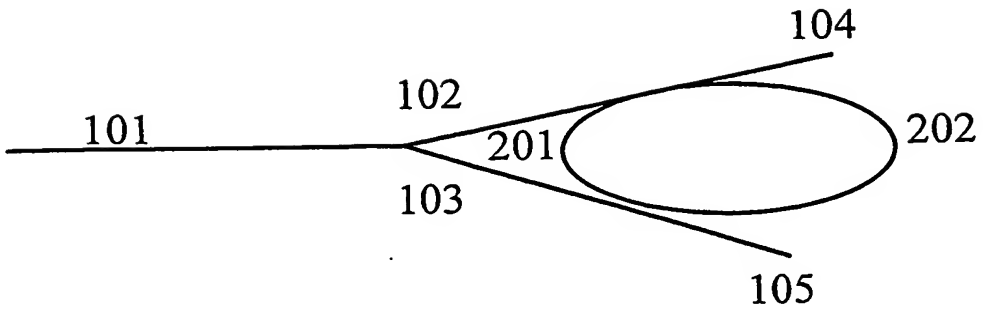

Figure 1a. Outline of bi direction tunable filter based on Sagnac Loop using a single resonator

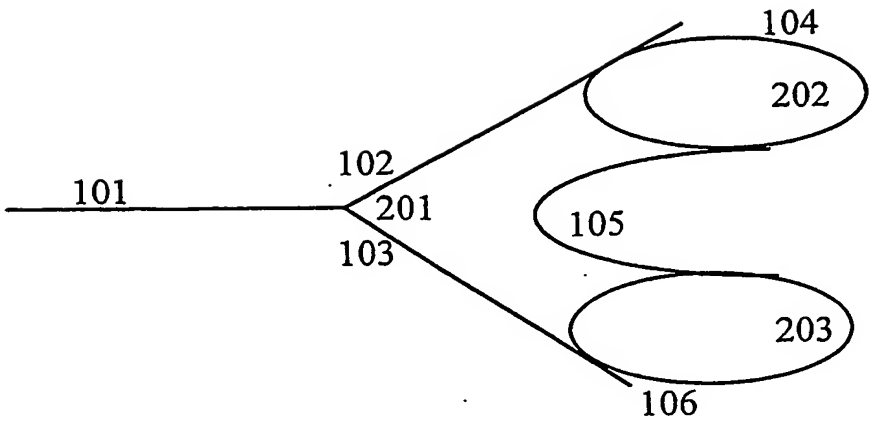

Figure 1b. Outline of bi direction tunable filter based on Sagnac Loop using two resonators

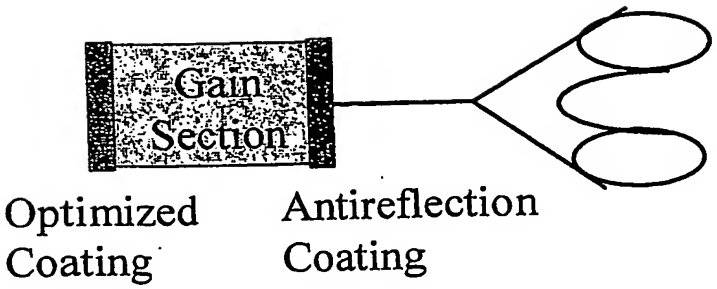

Figure 2. Laser cavity